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**BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES**

Application Number: 10/687,288
Filing Date: October 15, 2003
Appellant(s): YUEH ET AL.

Brent E. Vecchia
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed March 21, 2008 appealing from the Office action mailed September 28, 2007

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

5,358,599	Cathey et al.	10-1994
5,759,739	Takemura et al.	06-1998

2005/0074699	Sun et al.	04-2005
2004/0204328	Zhang et al.	10-2004
6,261,738	Asakura et al.	07-2001

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claim 27, is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claim 27, recites that the non-chemically amplified photoresist layer does not includes a photo acid generator. The specification, on page 6, paragraph no. [0023], teaches the use of a non-chemically amplified photoresist that includes a photoactive compound which upon exposure to light generated or forms an acid i.e., the photoactive compound is a photoacid generator. There is no disclosure in the specification teaching that the non-chemically amplified generator does not include a photo acid generator (PAG). Appropriate correction is required.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 21-25, 30-34, are rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent 5,759,739 (Takemura et al., hereinafter referred to as Takemura) in view of U. S. Patent Application Publication No. 2005/0074699 (Sun et al., hereinafter referred to as Sun).

Takemura, in the abstract, in col 1, lines 10-13, in col 3, lines 30-37, in col 4, lines 3-14, in col 5, lines 1-24, in col 6, lines 66-67, in col 7, lines 1-30, discloses a process of patterning features on the substrate (super LSIs) by forming a photoresist layer on the substrate (integrated device to be fabricated), wherein the photoresist includes an alkali-soluble resin, and a photoacid generator (photoactive), exposing the photoresist layer to EUV (excimer radiations) such that selected portions (exposed portions) are rendered soluble in the developer (during the developing process) by the acid generated by the photoacid generator during exposure, and the unexposed portions are inhibited from being rendered soluble in the developer (claims 21, 24, 30, and 32). Takemura, in col 4, lines 3-6, discloses that the alkali-soluble resin is polyhydroxystyrene (claims 22, and 31). Takemura, in col 10, lines 43-47, discloses that the photoactive agent contains a phenyl group (claims 23, and 33). Takemura, in

col 5, lines 20-24, discloses that the acid unstable group is a carbonyl group (claims 25, and 34).

The difference between the claims and Takemura is that Takemura does not disclose that the photoresist layer is non-chemically amplified.

Sun, in [0039], discloses that the chemically amplified photoresist layer can be replaced with a non-chemically amplified photoresist layer.

Therefore, it would be obvious to a skilled artisan to modify Takemura by replacing the photoresist layer of Takemura with a non-chemically amplified resist layer as suggested by Sun, because Sun, in [0039], discloses that the non-chemically amplified photoresist layer can be used for performing photolithographic processes in a shorter wavelength range (less than 365nm).

5. Claims 21, 26, 30, and 35, are rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent No. 5,358,599 (Cathey et al., hereinafter referred to as Cathey) in view of U. S. Patent Application Publication No. 2005/0074699 (Sun et al., hereinafter referred to as Sun).

Cathey, in the abstract, in col 3, lines 36-68, and in col 4, lines 5-44, in col 6, lines 18-20, discloses a process of patterning a semiconductor device in a lithography tool, the device including a plurality of structural layers by forming a photoresist layer on the structural layers, wherein the photoresist includes a photoactive compound that prevents selected portions of the resist form being solubilized by the developer, exposing the resist to UV radiation, and said acid generator renders selected portions

(unexposed non-crosslinked portion) of the resist soluble in the developer during the development step (claims 21, 30). Cathey, in col 4, lines 40-44, disclose that the resin is a poly vinyl phenol resin (claims 26, and 35).

The difference between the claims and Cathey is that Cathey does not disclose that the photoresist layer is non-chemically amplified.

Sun, in [0039], discloses that the chemically amplified photoresist layer can be replaced with a non-chemically amplified photoresist layer and can be used to perform exposures in less than 365nm (shorter wavelengths that includes EUV).

Therefore, it would be obvious to a skilled artisan to modify Cathey by replacing the photoresist layer of Cathey with a non-chemically amplified resist layer as suggested by Sun, because Sun, in [0039], discloses that the non-chemically amplified photoresist layer can be used for performing photolithographic processes in a shorter wavelength range (less than 365nm).

6. Claims 27-29, are rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent No. 5,358,599 (Cathey et al., hereinafter referred to as Cathey) in view of U. S. Patent Application Publication No. 2005/0074699 (Sun et al., hereinafter referred to as Sun) as applied to claims 21, 26, 30, and 35, above, and further in view of U. S. Patent Application Publication No. 2004/0204328 (Zhang et al., hereinafter referred to as Zhang) and U. S. Patent No. 6,261,738 (Asakura et al., hereinafter referred to as Asakura).

Cathey in view of Sun is discussed in paragraph no. 3.

Cathey, in the abstract, in col 3, lines 36-68, in col 4, lines 5-44, in col 5, lines 1-10, and in col 6, lines 18-44, discloses a process of patterning a semiconductor device in a lithography tool, the device including a plurality of structural layers (metal layers), patterning the photoresist layer formed on the structural layers to form a photoresist etch mask, wherein the photoresist etch mask is used to etch the exposed structural layers underlying the mask, followed by stripping the remaining photoresist mask (claim 28).

The difference between the claims and Cathey in view of Sun is that Cathey in view of Sun does not disclose that the patterns formed in the device have a critical dimension of approximately 15 nm. Cathey in view of Sun does not disclose that the photoresist does not include a photoacid generator (claim 27). Cathey in view of Sun does not disclose that the line wide roughness of the feature is less than 2 nanometers (claim 29).

Zhang, in [0019], discloses that the features formed in the device have a critical dimension less than 2nm, and a line width roughness of less than 2nm, and that the line width roughness is within 8% of the critical dimension.

The difference between the claims and Cathey in view of Sun and Zhang is that Cathey in view of Sun and Zhang does not disclose that the photoresist does not include a photoacid generator.

Asakura in col 1, lines 15-36, discloses that the non-chemically amplified photoresist does not have a photoacid generator.

Therefore, it would be obvious to a skilled artisan to modify Cathey in view of Sun by employing the method of patterning taught by Zhang, because Zhang, in [0019], discloses modifying the photoresist formulation and adjusting the latent image results in a pattern of reduced roughness. It would be obvious to a skilled artisan to modify Cathey in view of Sun and Zhang by employing the acid donors suggested by Asakura in the composition because Cathey discloses the use of a photo active compound in the composition and Asakura in col 1,lines 32-43, discloses that the claimed latent acid donors (photoactive compounds) are thermally stable and can be activated by light, UV or X-rays and can be used as catalyst in acid-catalyzed reactions.

(10) Response to Argument

GROUP I: CLAIM 27

A) Appellant cites paragraph [005], and [0031] of the instant specification, and argues that there is sufficient written description for claim 27.

The citations [005], and [0031], are cited below,

[0005] For chemically amplified photoresists, the mechanism is different. Instead of PAC, Photoacid generator (PAG) is used. The resin (PHOST) in the photoresists are not soluble in developer. Upon exposure to the hv light, the dissolution rate increases substantially. This is due to the acid resulting from exposure of the PAG. The generated acid will deblock the PHOST to form PHS which is soluble in developer. The disadvantage of this approach is that during the post-exposure bake process, the acid produced by the exposure of the photoacid generator (PAG) will diffuse into the film. The diffusion is non-uniform and produces a situation where the polymer lacks sufficient randomness to deblock, which exacerbates the LWR problem for all wavelengths.

[0031] While the invention has been described in terms of several embodiments, those skilled in the art will recognize that the invention is not limited to the embodiments described, but can be practiced with modification and alteration within the spirit and scope of the appended claims. The description is thus to be regarded as illustrative instead of limiting.

Claim 27, recites

27. (New) The method of claim 21, wherein the non-chemically amplified photoresist layer does not include a photo-acid generator (PAG).

The paragraphs cited above, viz., [0005], and [0031], do not suggest that the non-chemically amplified photoresist does not have a photoacid generator. The instant specification, on page 6, paragraph no. [0023], teaches the use of a non-chemically amplified photoresist that includes a photoactive compound which upon exposure to light generated or forms an acid i.e., the photoactive compound is a photoacid generator

because both photoacid generator and photoactive compound (PAC) generates an acid upon exposure to light.

GROUP II : CLAIMS 21-25 AND 30-34

(1) Appellant argues that neither Sun nor Takemura discloses or renders obvious a method of using a non-chemically amplified photoresist layer that includes a developer-soluble resin and a photoactive compound that inhibits the solubility of the developer-soluble resin that includes exposing selected portions of the non-chemically amplified photoresist layer to an extreme ultra-violet source.

Appellant's claims 21, and 30, recite the following, about the non-chemically amplified photoresist layer, see below,

depositing a non-chemically amplified photoresist layer upon the layer, the non-chemically amplified photoresist layer having a developer-soluble resin and a photoactive compound, the photoactive compound inhibiting solubility of the developer-soluble resin;

exposing selected portions of the non-chemically amplified photoresist layer to an extreme ultra-violet light source such that solubility of the selected portions of the non-chemically amplified photoresist layer is promoted; and

Takemura, in col 3, lines 13-37, and in col 4, 1-14, in col 5, lines 1-8, and lines 17-24, and in col 7, lines 1-9, discloses,

In chemically amplified positive resist compositions of the three-component system, known means for enhancing sensitivity is to use an onium salt as a photoacid generator capable of generating an acid upon light exposure. Resist compositions using onium salts tend to form an overhang (T top) in patterning, failing to achieve fine resolution. This is partially because of shortage of solubility required when a three-component system resist film upon exposure follows the mechanism that protective groups unstable to acid in the base resin and dissolution inhibitor are decomposed by the acid resulting from the photoacid generator so that the resist film becomes soluble in an aqueous alkali solution or developer. The dissolution inhibitor and base resin of the resist composition in unexposed areas remains insoluble in the aqueous alkali solution or developer while they lose the dissolution inhibition effect in exposed areas so that the dissolution rate is accelerated over that available prior to exposure. At the (exposed) surface of the resist film, however, less of the photoacid generator is distributed and the acid resulting therefrom can volatilize off or be inactivated by contamination from the ambient atmosphere so that protective groups survive in the base resin and dissolution inhibitor to retain the dissolution inhibition effect or form a substantially insoluble surface layer, resulting in a T-top pattern.

(C) a dissolution inhibitor of the general formula (2) and/or (3).

Preferably, alkali-soluble resin (B) is a polyhydroxystyrene in which some hydroxyl groups are replaced by acid unstable groups, having a molecular weight of 5,000 to 100,000.

DETAILED DESCRIPTION OF THE INVENTION

Component (A) is an onium salt of the general formula (1) which is capable of generating a strong acid upon exposure to high energy radiation such as deep-ultraviolet rays, electron rays and X-rays.

Onium salt (A) as the photoacid generator is preferably used in an amount of 0.5 to 15% by weight of the total weight of components (A) to (C). With less than 0.5% by weight of the photoacid generator, the composition would sometimes have low sensitivity though it still retains positive resist performance. As the amount of photoacid generator increases, the resist is increased in sensitivity and

The alkali-soluble resin as component (B) may be selected from polyhydroxystyrenes and novolak resins, for example. Since the novolak resins have light absorption in the far-UV region, use of polyhydroxystyrene is preferred. Preferred polyhydroxystyrenes are those in which some hydroxyl (OH) groups are replaced by acid unstable groups such as t-butyl (t-Bu) and t-butoxycarbonyl (t-Boc) groups.

The resist composition solution is spin coated on a substrate to form a resist film which is pre-baked and exposed to high energy radiation. Upon exposure, the photoacid generator is decomposed to generate an acid. Baking after exposure causes the acid to catalyze decomposition of the anti-dissolution or protective group, with the dissolution inhibition effect being lost. The resist film is then developed with an aqueous alkali solution and rinsed with water, yielding a resist having a positive pattern.

Takemura teaches forming a photoresist layer, wherein the photoresist layer includes an alkali-soluble resin, a photoacid generator that is capable of generating an acid upon exposure to light (i.e., a photoactive compound), wherein the photoacid generator inhibits the solubility of the resin in the unexposed areas (unexposed resist), and performing exposure to light at wavelengths as low as X-ray wavelengths (less than 10nm) i.e., exposure to EUV (EUV wavelength range 4nm -90nm) is possible, and rendering the exposed areas soluble so as to develop away the exposed areas. Although, Takemura does not teach that the photoresist composition used to form the

photoresist layer is a non-chemically amplified resist layer, Takemura teaches a resist layer has the same components as that of the resist layer recited claims 21, and 30. Sun is not depended upon to disclose the claimed composition of a non-chemically amplified layer. Takemura as discussed above is relied upon to disclose the claimed composition of the non-chemically amplified resist layer. Sun is relied upon to disclose the interchangeability and/or replaceability of the chemically amplified resist layer with a non-chemically amplified resist layer.

(A) Appellant argues that the section of Sun relied upon does not disclose that a non-chemically amplified photoresist in general be useful for EUV lithography, but only for KrF or shorter wavelengths.

Sun, in [0039], discloses that at exposures performed at wavelengths shorter than KrF, the chemically amplified photoresist layer can be replaced with a non-chemically amplified resist layer. Wavelengths shorter than KrF wavelengths includes EUV, and X-rays, and as cited in argument **GROUP II** (1) above, Takemura already suggests exposure in a wavelength of about 4-10nm (exposure to X-ray include wavelengths that are less than 10nm) i.e., EUV wavelength exposure are possible.

(2) Appellant argues that Takemura should not be combined with Sun since Takemura pertains to chemically amplified photoresist layers and Sun pertains to non-chemically amplified photoresist layers.

Sun does not suggest only the use of non-chemically amplified resist layer, Sun teaches as discussed in paragraph **GROUP II** (A) above, the interchangeability of chemically amplified resist with a non-chemically amplified resist layer at very low exposure wavelengths. Takemura, as discussed in **GROUP** II (1) above, teaches a photoresist layer that has the same composition as that of the claimed non-chemically amplified resist layer, and Takemura also suggest the use of exposure wavelength range that are as a low as X-ray wavelengths for the same composition, and therefore Takemura can be combined with Sun.

GROUP III: CLAIMS 21, 26, 30, AND 35

(1) Appellant argues that neither Sun nor Cathey discloses or renders obvious a method of using a non-chemically amplified photoresist layer that includes a developer-soluble resin and a photoactive compound that inhibits the solubility of the developer-soluble resin that includes exposing selected portions of the non-chemically amplified photoresist layer to an extreme ultra-violet source.

Appellant's claims 21, and 30, recite the following, about the non-chemically amplified photoresist layer, see below,

depositing a non-chemically amplified photoresist layer upon the layer, the non-chemically amplified photoresist layer having a developer-soluble resin and a photoactive compound, the photoactive compound inhibiting solubility of the developer-soluble resin;

exposing selected portions of the non-chemically amplified photoresist layer to an extreme ultra-violet light source such that solubility of the selected portions of the non-chemically amplified photoresist layer is promoted; and

Cathey, in col 4, lines 12-54, discloses,

patterns that could occur by using positive resist (see FIG. 4). The process of the present invention for forming a negative photoresist etch mask on a major surface of the outer semiconductor device can further comprise coating the major surface of the semiconductor device with a layer of a negative photosensitive resin. The negative photosensitive resin is then exposed to an optical image comprising a plurality of photoresist lines arranged in a predetermined pattern which defines a plurality of spaces therebetween. The exposed negative photosensitive resin then produces an in situ catalyst at any sites contacted by the optical image. The exposed negative photosensitive resin is then crosslinked at the sites contacted by the optical image in the predetermined pattern. Finally, the crosslinked polymerized negative photosensitive resin is developed with a photodeveloping agent to remove the non-crosslinked polymerized negative photosensitive resin and thereby forming said negative photoresist etch mask. Although most high-resolution negative-type photoresists can be employed for this purpose, the negative photosensitive resin typically comprises an acid-catalyzed photosensitive resin, and the photodeveloping agent is typically a dilute hydroxide solution. Preferably, the dilute hydroxide solution is dilute tetramethyl ammonium hydroxide, the negative photosensitive resin comprises a poly p-vinyl phenol resin and an acid-activated crosslinking agent. The photoacid generator releases an acid upon exposure to UV light which causes crosslinking to occur in the film. As for the preferred formulation, the acid-catalyzed photosensitive resin comprises poly p-vinyl phenol resin, an acid-activated crosslinking agent, and a photoacid generator.

The subject process also relates to the etching of a semiconductor device having a re-entrant profile area which causes residual positive photoresist material to remain therewithin after formation of an etch mask of the positive photoresist material. As previously discussed, a negative photoresist etch mask is formed on a major surface of the outer conductive film structural layer. The etch mask comprises a plurality of photoresist lines arranged in a predetermined pattern which defines a plurality of spaces therebetween, which in

a photoresist layer that has the claimed alkali soluble resin (poly vinyl phenol resin claimed in claim 26), a photoacid generator that generates an acid upon exposure i.e., it is a photoactive compound, wherein the photoacid generator (or photoactive compound) prevents selected portions of the resist from being solubilized by the developer, and renders soluble, selected portions such as the unexposed areas i.e., the non-crosslinked portions of the resist, in the developer during the development step. Sun is relied upon to disclose the interchangeability of the disclosed chemically amplified resist with a non-chemically amplified resist that can be used for performing exposures in wavelengths shorter than KrF wavelengths i.e., EUV wavelengths and X-rays. Sun, in [0016], [0017], discloses that the photoresist layer can be exposed in wavelengths such as 4nm, 11nm etc., i.e., performing exposure at EUV wavelengths.

(2) Appellant argues that Cathy should not be combined with Sun since Cathey pertains to chemically amplified photoresist layers and Sun pertains to non-chemically amplified photoresist layers.

Sun does not suggest only the use of non-chemically amplified resist layer, Sun teaches as discussed in paragraph **GROUP III** (1) above, the interchangeability of chemically amplified resist with a non-chemically amplified resist layer at very low exposure wavelengths. Sun, in [0016], [0017], discloses that the photoresist layer can be exposed in wavelengths such as 4nm, 11nm etc., i.e., performing exposure at EUV wavelengths. Cathey, as discussed in **GROUP III** (1) above, teaches a photoresist layer that has the same composition (including the same resin viz., poly vinyl phenol)

and/or components as that of the claimed non-chemically amplified resist layer and is therefore capable of being used in the claimed exposure wavelengths.

GROUP IV: CLAIMS 27-29

(A) Appellant argues Zhang and Asakura do not disclose or render obvious a method of using a non-chemically amplified photoresist layer that includes a developer-soluble resin and a photoactive compound that inhibits the solubility of the developer-soluble resin and that includes exposing selected portions of the non-chemically amplified photoresist layer to an extreme ultra-violet lights source.

Zhang and Asakura are not relied upon to disclose the above argued non-chemically amplified photoresist layer. Takemura and Cathey teaches the claimed photoresist layer composition. Asakura is only relied upon to disclose a non-chemically amplified resist that does not contain a photoacid generator (as claimed in claim 27), and Zhang is relied upon to disclose the claimed critical dimension values. See arguments addressed in **GROUP II** (1), and **GROUP III** (1) above.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

dcd

/Daborah Chacko-Davis/

Examiner, Art Unit 1795

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